Periodic Table of Elements

The Search for Order and Organization

- How do you organize your CD collection?
- How are DVDs organized on those Red Box machines?
- How are books organized in a library?

- How do you organize your CD collection?
- How are DVDs organized at BlockBluster?
- How are books organized in a library?

WHY DO WE ORGANIZE THINGS ANYWAY?

- How do you organize your CD collection
- How are DVDs organized at BlockBuster?
 Organized by "theme"
- How are books organized in a library?
 Organized by "theme"
 WHY DO WE ORGANIZE THINGS ANYWAY?
 - ANS: To make things easier to find and to be able to group things according to trends.

- The placement of elements on the modern periodic table reveals patterns:
 - The atomic structure of atoms (number of protons, neutrons, electrons, and energy levels)
 - The properties of each element.

Modern-day Periodic Table

Today, there are 115 known elements (115 different combinations of protons – some natural and some man-made).

- A few are known to exist, but:
- have not yet been discovered OR
- are too unstable to study.

Many of these elements have only recently been discovered or created in a lab...

Better Science = More elements Discovered

Up until 1750s, there were only 17 known elements...

But as these elements were put in systematic (orderly) groupings, scientists began to discover more elements.



Antoine Lavoisier (1700s) •Activity: Organizing a bag of stuff – How would you put these objects in order??

Attempt #1:

Organizing Periodic Table Attempt #1: Antoine Lavoisier (1700s)



•He was a French chemist who grouped the known elements into 4 categories.

These groupings were based on:

 substances with similar characteristics that could not be broken down any smaller with the technology of the 1700s

Attempt #1: 1700s

Antoine Lavoisier's four categories were

- 1. metals → metallic materials
- 2. nonmetals → not metallic
- 3. gases → those belonging to all living things in nature
- 4. and earths → elements that looked like rock/dirt

Attempt #1: 1700s



However, these groupings did not always work and some elements fell into more than one category....

Think of your way of categorizing music on your ipods...music you consider "modern rock" may be considered "alternative" by someone else

Attempt #2: Mendeleev's Periodic Table





Russian Chemist and Science Teacher in the 1860s.

•Was writing a chemistry book and was trying to figure out how to organize the known elements.

•He came up with a solution based on the game solitaire.

How To Play Solitaire

- In certain versions of Solitaire, the player tries to sort a deck of cards by suit (hearts, diamonds, etc.) and value.
- Mendeleev tried to do the same thing for the elements...he made a "deck of cards" out of the elements



Mendeleev's Organized Table

Characteristics used by Mendeleev: - Mendeleev put the elements in rows by increasing atomic masses.

- He started a new row every time chemical properties repeated themselves.



1	2	3	4	5	6	7
8	9		11	12	13	14
	16		18	19	20	21
22	23	24	25		27	
29		31	32	33		35
36	37	38			41	42

Mendeleev's Finishing Touches **Characteristics used** by Mendeleev: - This produced columns with similar properties. If there seemed to be a missing element, he left a gap in the table.

Mendeleev's Finishing Touches

 Notice that this left blank spots in the grid of elements.

Able to make predictions about the unknown elements due to placement.



1	2	3	4	5	6	7
8	σ.		11	12	13	14
	16		18	19	20	21
22	с с	24	25		27	
29		31	32	33	1	35
36	37	38			41	42

Final Results: Mendeleev's Periodic Table

Rethen	Gruppe I. — R ² O	Gruppe П. — RÖ	Gruppe III. R ² 0 ³	Gruppe IV. RH ⁴ RO ²	Gruppe V. RH ³ R ² O ⁵	Gruppe VI. RH ² RO ³	Gruppe VII. RH R ² H ⁷	Gruppe VIII. RÖ ⁴
1 2 3 4	H = 1 Li = 7 Na = 23 K = 39	<u>Be = 9, 4</u> Mg = 24 Ca = 40	B = 11 A1 = 27, 3 - = 44	$\frac{C = 12}{Si = 28}$ Ti = 48	$\frac{N=14}{P=31}$ $V=51$	$\frac{O = 16}{S = 32}$ Cr = 52	$\frac{F = 19}{Cl} = 35, 5$ Mn = 55	Fe = 56, Co = 59,
5. 6	(Cu = 53) Rb = 85	Zn = 65 S = 87	- —= 68. ?Yt ≓ 88	—= 72 Zr = 90	As = 75 Nb = 94	Se = 78 Mo = 96	Br = 80 − = 100	Ni = 59, Cu = 63. Ru = 104, Rh = 104, Pd = 106. Ag = 108
7 8 9 10	(Ag = 108) Cs = 133 ()	Cd = 112 Ba = 137 —	In = 113 ?Di = 138 	Sn = 118 ?Ce = 140 	Sb = 122 	Te = 125 	J = 127 	Os = 195, Ir = 197,
11 12	(Au = 198) -	Hg = 200	T1=204	Pb = 207 Th = 231	Bi≓208 —	U = 240	_	Pt = 198, Au = 199,

Final Results: Notice the blank spots on the element table.

Rethen	Gruppe I. — R ² O	Gruppe II. — RÖ	Gruppe III. R ² 0 ³	Ġruppe IV. RH ⁴ RO ²	Gruppe V. RH ³ R ² O ⁵	Gruppe VI. RH ² RO ³	Gruppe VII. RH R ² H ⁷	Gruppe VIII. RO ⁴
1 2 3	$H = 1$ $\frac{Li_{i} = 7}{Na = 23}$ $K_{i} = 20$	$\frac{Be = 9, 4}{Mg = 24}$	$\frac{B=11}{A1=27,3}$	$\frac{ \mathbf{C} = 12 }{\mathrm{Si} = 28}$	$\frac{N=14}{P=31}$	$\frac{O=16}{S=32}$	$\frac{\mathbf{F} = 19}{C1 = 35, 5}$	T 56 d 50
4 5. 6	Rb = 39 Rb = 85	Zn = 65 S = 87	68. ?Yt - 00	-= 72 Zr = 90	v = 51 As = 75 Nb = 94	Se = 78 Mo = 96	Dr = 80	Ru = 104, Rh = 104,
7 8 9	(Ag = 108) Cs = 133 ()	Cd = 112 Ba = 127	In = 113 ?Di = 138 —	Sn = 118 ?Ce = 140 —	- Sb = 122 	- Te = 125	J = 127	Pd = 106, Ag = 108
10 11 12	 (Au = 198) 	— Hg ≓ 200 —	Er = 178 Tl = 204 -	?La = 180 Pb = 207 Th = 231	Ta = 182 — Di - 208 —	W = 184	-	:Os = 195, Ir = 197, Pt = 198, Au = 199,

Mendeleev's Periodic Table had columns with the same properties and the masses of each element increasing as you went down the column. He left blank spaces for unknown elements

Reihen	Gruppe I. — R ² O	Gruppe П. — RÖ	Gruppe III. R ² O ³	Ğruppe IV. RH ⁴ RO ²	Gruppe V. RH ³ R ² 0 ⁵	Gruppe VI. RH ² RO ³	Gruppe VII. RH R ² H ⁷	Gruppe VIII. RO ⁴
1 2 3	$H = 1$ $\frac{Li = 7}{Na = 23}$	$\frac{Be = 9, 4}{Mg = 24}$	$\frac{B=11}{Al=27,3}$	$\frac{ \mathbf{C} = 12}{ \mathbf{S} = 28}$	$\frac{N=14}{P=31}$	$\frac{O = 16}{S = 32}$	$\frac{F = 19}{C1 = 35, 5}$	T (1)
4 5. б	K = 39: (Cu = 53) Rb = 85	Ca = 40 Zn = 65 S = 87	= 44 = 68 ?Yt = 88	-11 = 48 = 72 Zr = 90	V = 51 As = 75 Nb = 94	Cr = 52 Se = 78 Mo = 96	Mn = 55 Br = 80 − = 100	Fe = 56, Co = 59, Ni = 59, Cu = 63. Ru = 104, Rh = 104,
7 8 9	(Ag = 108) Cs = 133 ()	Cd = 112 Ba = 137 —	In = 113 ?Di = 138 	Sn = 118 ?Ce = 140 	Sb = 122 	$- \frac{\text{Te} = 125}{-}$	J = 127 	Pd = 100, Ag = 108
10 11 12	- (Au=198) -	— Hg≓200 —	TI=178 TI=204	Pb = 207 Th = 231	Bi≓ 182 Bi≓ 208	w = 184 U = 240	_	Pt = 198; $Au = 199$,



BIG IDEA: Why was Mendeleev's Periodic Table so Important?

1. Mendeleev left blanks in his table for unknown elements that would complete the properties pattern but not yet discovered.

2. This reinforced the idea that an <u>element's location</u> on the periodic table was related to its properties. No longer did students need to memorize the properties of all elements...just become familiar with one or two in a column and the rest would be similar.



BIG IDEA: Why was Mendeleev's Periodic Table so Important?

3. The table worked <u>SO WELL</u>, that Mendeleev was able to make predictions about the unknown elements by looking at the surrounding known elements.

Did these predictions work?

- Mendeleev used his table to predict the existence of a metal that would lay below aluminum in the table.
- He hypothesized that the metal would be extremely soft with a VERY LOW melting point.
- In 1985, the metal Gallium was discovered. This metal had the mass and characteristics predicted by Mendeleev.





What Mendeleev Didn't Know

- Mendeleev did not know that every atom of the same element has the <u>SAME</u> number of protons...
- The "atomic masses" he used on his periodic table were <u>NOT</u> really the masses of individual atoms (the technology did not exist to measure atoms).
- Instead, the masses were determined through experiments and were measuring a larger amount of material.

What Mendeleev Didn't Know

 Remember, Mendeleev organized the elements into rows based on increasing atomic masses.



 The problem → Mendeleev found that some elements did not quite fit the pattern of similar characteristics when organized by increasing <u>atomic masses</u>.

Attempt #3: Henry Moseley

 Henry Moseley shot x-rays at the known elements and was able to determine the number of protons found in each element's atoms.



 Moseley arranged elements by increasing atomic number (number of protons) which fixed many of the discrepancies (problems) with Mendeleev's table.

Looking at the Modern Periodic Table

hydrogen																		helium
1																		2
н																		He
1.0079		-		Key:														4.0026
lithium 2	beryilum element name boron carbon nitrogen oxygen flucine 4 atomic number 5 6 7 8 9													neon 10				
1	De																	
	Ве														Ne			
6.941	9.0122 mogposium			atomic we	ight (mean reli	ative mass)							10.811 okuminium	12.011	14.007 phosphorus	15.999	18.998 ablarina	20.180
11	12												13	14	15	16	17	18
Na	Ma												ΔΙ	Si	D	9	CL	Δ
	ivig]													20.074	20.005		20.040
potassium	calcium	1	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	2e.086 germanium	arsenic	selenium	bromine	krypton
19	20		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca]	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.098	40.078		44.956	47 867	50.942	51,996	54.938	55 845	58,933	58 693	63 546	65.39	69 723	72.61	74 922	78.96	79.904	83.80
rubidium	strontium	1	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	xenon
37	38		39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr		Y	Zr	Nb	Мо	TC	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Те		Xe
85.468	87.62		88.906	91.224	92.906	95.94	[98]	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.60	126.90	131.29
55	56	57-70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Ce	Ra	*	1.1.1	LIF	Ta	۱۸/	Po	Oe	le l	Dt	Δ	Ha	TL	Dh	B i	Po	۸ŧ	Dn
US	Da		Lu	п	Ia	vv	Re	US		гι	Au	пу		FD	DI	FU	Αι	КП
132.91 francium	137.33 radium		174.97 lawrencium	178.49 rutherfordium	180.95 dubnium	183.84 seaborgium	186.21 bohrium	190.23 hassium	192.22 meitnerium	195.08 ununnilium	196.97 unununium	200.59 ununbium	204.38	207.2 ununguadium	208.98	[209]	[210]	[222]
87	88	89-102	103	104	105	106	107	108	109	110	111	112		114				
Fr	Ra	**	Lr	Rf	Db	Sa	Bh	Hs	Mt	Uun	Uuu	Uub		Uua				
[223]	[226]		[262]	[261]	[262]	[266]	[264]	[269]	[268]	[271]	[272]	[277]		[289]				
			lanthanum	cerium	praseodymium	neodymium	promethium	samarium	europium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterblum		
			57	58	59	60	61	62	63	64	65	66	67	68	69	70		
	*lantha	anoids	la	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dv	Ho	Fr	Tm	Yb		
			138.01	140.12	140.91	144.24	[145]	150.36	151.06	157.25	158.03	162 50	164.93	167.26	168.93	173.04		
			· ·····		1	1-1-1-2-1	1.40		101.00	107.20	100.00	102.00	104.00	107.20	100.00	170.04		
			actinium	thorium	protactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	einsteinium	fermium	mendelevium	nobelium		
			actinium 89	thorium 90	protactinium 91	uranium 92	neptunium 93	plutonium 94	americium 95	96	berkelium 97	californium 98	einsteinium 99	fermium 100	mendelevium 101	nobelium 102		
	**actin	oids	actinium 89 AC	90 Th	91 Pa	uranium 92 U	93	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102		

The element with the next atomic number has characteristics that match the first column.

Principal of Periodic Law: The modern periodic table organizes elements by atomic number, groups (columns) of elements have same characteristics.

Organizing the Modern Periodic Table

Energy Levels, Orbitals, Electrons										
Energy	Number	Maximum								
Level	of	# of								
(PERIOD)	Orbitals	electrons								
1	1	2								
2	4	8								



•Each row in the Periodic Table is called a "**period**" and tells you the number of energy levels for the first three rows.

**actinoids

Ac

Th | Pa

U

Np

Pu

Am Cm

Bk

Cf

Es | Fm

Md No

Organizing the Modern Periodic Table

Energy Levels, Orbitals, Electrons										
Energy Level	Number of Orbitals	Maximum # of electrons								
1	1	2								
2	4	8								



•The first element in EACH period has all prior energy levels completely filled and ONE electron in the new energy level.

•<u>EX</u>: Sodium is in Period 3, so Energy Levels 1&2 are filled, with ONE electron in the 3rd Energy Level.

Looking at the Periodic Table

•Each column in the periodic table is called a "group" and the group number tells you the number of valence electrons in each atom.

• Each group has a specific set of "properties".

hydrogen																		helium
1	1																	2
H																		He
1.0079 lithium	beryllium			Key:	element name	,						r	boron	carbon	nitrogen	oxygen	fluorine	4.0026 neon
3	4			ate	omic num	ber							5	6	7 Ĭ	8	9	10
Li	Be			S	ymb	ol						ſ	B	С	N	0	F	Ne
sodium	9.0122 magnesium			atomic we	ignt (mean reis	ative mass)							aluminium	silicon	phosphorus	sulfur	chlorine	20.180 argon
11	12												13	14	15	16	17	18
Na	Mg											Í	AI	Si	P	S	CI	Ar
potassium	calcium		scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	germanium	arsenic	selenium	bromine	39.948 krypton
19	20		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca		Sc	Ti	V	Cr	Mn	Fe	Со	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.098 rubidium	40.078 strontium		44.956 vttrium	47.867 zirconium	50.942 niobium	51.996 molybdenum	54.938 technetium	55.845 ruthenium	58.933 rhodium	58.693 palladium	63.546 silver	65.39 cadmium	69.723 indium	72.61 tin	74.922 antimony	78.96 tellurium	79.904 iodine	83.80 xenon
37	38		39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr		Y	Zr	Nb	Мо	Тс	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Те		Хе
85.468 ceesium	87.62 barium		88.906 lutetium	91.224 befolum	92.906 tentalum	95.94 tupgeten	[98] rhenium	101.07	102.91 iridium	106.42 platinum	107.87 cold	112.41 mercury	114.82 theilium	118.71 lead	121.76 bismuth	127.60 polonium	126.90 estatina	131.29 redop
55	56	57-70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	*	Lu	Hf	Та	W	Re	Os	Ir	Pt	Au	Hg	TI	Pb	Bi	Ро	At	Rn
132.91 francium	137.33 radium		174.97 Jawrencium	178.49 rutherfordium	180.95 dubnium	183.84 seaborgium	186.21 bobrium	190.23 hassium	192.22 meitnerium	195.08 upuppilium	196.97 upupupium	200.59 upunbium	204.38	207.2 ununguadium	208.98	[209]	[210]	[222]
87	88	89-102	103	104	105	106	107	108	109	110	111	112		114				
Fr	Ra	**	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub		Uuq				
[223]	[226]	L	[262]	[261]	[262]	[266]	[264]	[269]	[268]	[271]	[272]	[277]]	[289]	J			
			lanthanum 57	cerium 58	praseodymium 59	neodymium 60	promethium 61	samarium 62	europium 63	gadolinium 64	terblum 65	dysprosium 66	holmium 67	erbium 68	thulium 69	ytterbium 70		
	*lantha	inoids	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb		
			actinium	thorium	protactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	einsteinium	fermium	mendelevium	nobelium		
1			89	90	91	92	93	94	95	96	97	98	99	100	101	102		
	**actine	oids	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		
			[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]		

Organizing the Modern Periodic Table

Energy Levels, Orbitals, Electrons									
Energy	Number	Maximum	sodiu 11						
Levei	Orbitals	electrons	22.99 potass 19 K 39.09 rubidi 37						
1	1	2	85.46 caesiu 55						
2	4	8	132.6 francia 87						





•The first element in EACH period has all prior energy levels completely filled and ONE electron in the new energy level.

 The group number tells you the number of electrons in the outer most energy level. These are called the "valence electrons"

Looking at the Periodic Table

- •Each column in the periodic table is called a "group"
- Each group has a specific set of "properties"



- The elements in each "group" have similar properties because they have the same number of outer or valence electrons.
- The group number will tell you how many valence electrons elements in that group or column have.

Looking at the Periodic Table



• Elements from Periods 6 and 7 are broken up and placed at the bottom of the page to make the periodic table more compact. (These energy levels contain a LARGE number of orbitals).

• We will see in future lessons that the reactivity of an element is MOSTLY dependent on how many electrons are in an atom's outer (highest) energy eve



•Remember, the number of electrons in the outer energy level is indicated by the group the element is found in.



2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 1718

•Remember, the number of electrons in the outer energy level is indicated by the group the element is found in.



<u>Group 1</u>: One electron in outer energy level

•Remember, the number of electrons in the outer energy level is indicated by the group the element is found in.



<u>Group 2</u>: Two electron in outer energy level
•Remember, the number of electrons in the outer energy level is indicated by the group the element is found in.

8 9 10 11 12 13 14 15 16 1718 2 5 6 7 2 н He 5 10 3 4 atomic numbe 7 8 9 0 F. Li Be В Ν Ne symbol 14.007 argo: 18 11 13 15 16 17 Ρ S CI Na AI Ma Ar 30 974 39,948 24 305 35.453 31 galliur 20 21 22 23 24 25 26 27 28 29 33 34 35 36 V Cr Mn Ni Ζ Ga Br Kr κ Ti Fe Cu Se Ca Sc Co G As 40.078 47.867 adm 41 palladiu 46 hodiur 45 silver 47 elluriu 52 iodine 53 xenon 54 40 43 51 37 38 39 41 42 44 Rb С Sr Υ Nb Мо Rh Pd **Ag** Sb Т Хе Zr Tc Ru Te In [98] 112 121 76 bariun 56 ungste 74 theniur 75 gold 79 nerci 80 statine 85 55 57-70 71 72 73 76 77 78 83 84 86 81 Cs W H Ba Hf Та Re Pt тι Bi Po At Rn Lu Os lr. Au b 137.33 178.4 186.21 174 07 183.84 190.23 192.22 franciu 87 radiun 88 112 104 106 107 109 110 111 89-102 103 105 108 14 Fr Ra Rf Sg Bh Hs Mt Db Uul Lr Uun Uuu uq 289] 58 67 57 59 60 61 62 63 64 65 66 69 70 Nd Pm| Sm Eu Th Er Pr Gd Yb La Ce JV Tm *lanthanoids 151.96 utoniu 94 89 90 91 92 93 97 99 100 101 102 Pa U Am Cm Cf Es Np Bk **actinoids Ac Th Fm Md No

Group 13: Three electron in outer energy level...to remember how many electrons, just cross out the "1" in the group number

•Remember, the number of electrons in the outer energy level is indicated by the group the element is found in.



Group 14: Four electron in outer energy level...to remember how many electrons, just cross out the "1" in the group number

3

2

 Since we really only care about how many electrons an atom has in the outer energy level, we use what is called a Lewis Dot Structure.

9 10 11 12 13 14 15 16 1718 2 н He 10 3 4 atomic numbe 5 6 7 8 9 0 F. Li Be В С Ν Ne symbol 9.0122 14.007 argor 18 11 12 15 16 17 13 14 S CI Na Si Ρ Ma AI Ar 30.974 39,948 24 305 28.086 32.069 35,453 galliur 31 19 20 21 22 23 24 25 26 27 28 29 30 32 33 34 35 36 Κ V Cr Fe Ni Cu Zn Br Ti Ga Se Kr Ca Sc Mn Co Ge As 40.078 47.867 palladiu 46 silve 47 admiu 48 elluriu 52 iodine 53 xenor 54 40 50 51 37 38 39 41 42 43 44 45 49 Rb Υ Rh Pd Cd Sb Т Хе Sr Zr Nb Мо Tc Ru Ag Sn Te In [98] 102.91 106.42 112.41 121 76 bariun 56 ungste 74 heniu 75 latinu 78 gold 79 lead 82 statine 85 rador 86 55 83 57-70 71 72 73 76 77 80 81 84 W Cs Ba Hf Re Pt Hg TL Pb Bi Po At Rn Та Ir Au Lu Os 137.33 178.49 186.21 174.97 183.84 190.23 192.22 195.08 radiun 88 franciu 87 110 104 106 107 112 89-102 103 105 108 109 111 114 Fr Sg Ra Rf Bh Hs Mt Lr Db Uub Uuq Uun Uuu [289] 58 57 59 60 61 62 63 64 65 66 67 68 69 70 Pr Nd Pm Sm Ho Er Gd Tb Dy Yb La Ce Eu Tm *lanthanoids 138.91 140.12 164.03 168.03 173.04 89 90 91 92 93 94 95 96 97 98 99 100 101 102 Pa U Pu Cf Bk Es **actinoids Ac Th Np Am Cm Fm Md No

8

6

Lewis Dot Structure: A method to indicate how many valence electrons an atom has. This method is commonly used for Groups 1,2,13-18

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.



Example: Sodium (Na) is in Group 1, so the Lewis Dot Structure would be: Na with a single dot to represent "1" electron in the outer energy level.

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.



Example:

Na

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.



Example: Calcium (Ca) is in Group 2, so the Lewis Dot Structure would be: Ca with two dots to represent "2" electrons in the outer energy level.

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.



Example:

Ca:

3 4 6

2

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.

8 9 10 11 12 13 1<u>4</u> 15 16 1718 2 н He berylliu 4 xyge 8 6 7 10 3 atomic numbe 9 С 0 F. Li Be Ν symbol Ne 9.0122 15.999 sphore 15 argor 18 ignes 12 11 14 16 17 Si D S CI Na Ma Ar .974 39,948 24 305 28.086 32.065 35,453 19 20 21 22 23 24 25 26 27 28 29 30 32 34 35 36 V Cr Zn Se Br Κ Ti Fe Ni Cu Kr Ca Sc Mn Co Ge S a 40.078 47.867 palladiu 46 silve 47 admiu 48 an 50 elluriu 52 iodine 53 xenor 54 40 45 37 38 39 41 42 43 44 Rb Υ Nb Rh Ag Cd b Т Хе Sr Zr Мо Tc Ru Pd Sn Te 87.62 [98] 102.91 106.42 112.41 1.76 127.60 muth B3 bariun 56 ungste 74 theniur 75 latinu 78 gold 79 les. 82 statine 85 rador 86 aesiur 55 nercur 80 73 57-70 71 72 76 77 84 W Bi Cs Ba Hf Та Re Pt Hq Pb Po At Rn Os lr. Au Lu 137.33 178.49 183.84 186.21 132.01 174 97 190.23 192.22 195.08 207.2 87 88 104 106 107 110 111 112 114 89-102 103 105 108 109 Fr Ra Rf Sg Bh Mt Lr Db Hs Uub Uua Uun Uuu [289] 58 57 59 60 61 62 63 64 66 67 68 69 70 Nd Pm Sm Но ਦ Pr En Tb Yb La Ce Dy Tm *lanthanoids **_**u 140.12 157.25 168.03 173.04 89 90 92 96 97 98 99 100 101 102 Pa Pu Cf **actinoids Th Am Cm Bk Es Ac Np Fm Md No

Example: Carbon (C) is in Group 14, so the Lewis Dot Structure would be: C with four dots to represent "4" electrons in the outer energy level.

 Lewis Dot Structure: Write the element's symbol and then an amount of dots equal to the electrons in the outer energy level.

Example:

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 1718



• Why are there only 8 possible Lewis Dot Structure Patterns?

- Why are there only 8 possible Lewis
 Dot Structure Patterns?
- <u>ANS</u>: Because the atoms that we are concerned with want to have 8 electrons in their outer energy level.

–Except for energy level one which holds 2 electrons

Perfection!

- Are there any atoms that already have a perfect number of valence electrons?
- YES! \rightarrow Group 18



Rules for Writing Lewis Dot Structures

Please note that you can place the first two dots on any side, but the rest of the dots should be placed in either a clockwise or counter clockwise manner, with <u>no side</u> receiving two dots until each side gets one.

X. X. X. X.

Why Lewis Dot Structure is important lons

- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no</u> <u>longer neutral</u>. → Already played the game!
- End with either 8 electrons by gaining new electrons or losing 1 or 2 electrons in the outside energy level so it disappears revealing a full inner energy level.
- Na⁺ \rightarrow sodium lost one electron so it is positive.
- $Mg^{2+} \rightarrow lost two electrons so it is positive.$
- $Cl^2 \rightarrow$ gained one electron so it is negative

Draw the diagram



How many energy levels are there?

How many valence electrons are there?





How many energy levels are there? 3

How many valence electrons are there? 2



Electron THE BIG RULE: most atoms are happiest when they have a FULL outer energy level (typically 8)

• If there are only 1 or 2 electrons in the outer energy level than the atom wants to LOSE the extra electrons.



Example: this atom has 2 valence electrons.







Example: this atom has 2 valence electrons.

•The atom will lose the valence electrons.

 Without any electrons, the energy level DISAPPEARS, and we are left with the full energy level directly below:















- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no</u> <u>longer neutral.</u>
- Ions are either positive (lost electrons) or negative (have gained electrons)

Everything starts out NEUTRAL

EX: Lost electrons to make outer energy level disappear: Li⁺, Na⁺ Be²⁺, Ca²⁺

Ex: Gained electrons to make outer energy level filled: F⁻, Cl⁻, O²⁻

Ion Groups

 Ions (atom with a charge) that are negative (more electrons than protons) are called <u>anions</u>.

 Ions that are positive (more protons than electrons) are called <u>cations</u>.

- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no longer neutral.</u>
- Ions are either positive (lost electrons) or negative (have gained electrons)



Sodium Atom = Na

- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no longer neutral.</u>
- Ions are either positive (lost electrons) or negative (have gained electrons)



Electron is lost, so the Sodium atom Na has a net <u>POSITIVE</u> charge.

Ion written as Na⁺

- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no longer neutral.</u>
- Ions are either positive (lost electrons) or negative (have gained electrons)



Fluorine Atom = F

- <u>lons</u> are atoms that have either LOST or gained electrons to have a full outer energy level. → <u>no longer neutral.</u>
- Ions are either positive (lost electrons) or negative (have gained electrons)



Electron is gained giving a net negative charge of

Three General Categories

 Elements are classified as metals (left), nonmetals (right), and metalloids (semiconductors) (middle).









METALS

• Metals are good conductors of electrical current and heat.

• Except for mercury, metals are solid at room temperature.

• Most metals are <u>malleable</u> (able to be hammered without breaking.)

• Most metals are <u>ductile</u> (can be pulled into a wire).

TRANSITION METALS



- Transition metals are elements that form a bridge between the elements on the left and right sides of the table (Groups 3-12)
 - Since Transition Metals do not follow the rule of electrons in outer energy level matching with the group number, we will not be dealing much with these.

NONMETALS



• Poor conductors of heat and electric current (insulators).

• Many have <u>LOW</u> <u>BOILING POINTS</u> (gases at room temperature).

METALLOIDS or SEMICONDUCTORS



 Metalloids or Semiconductors are elements that fall between those of metals and nonmetals (have characteristics of both metals and nonmetals)

Very Important Semiconductor

Silicon (has 4 valence electrons and typically found combined with oxygen in nature)

- Has a very high melting point (doesn't melt easily) like a nonmetal.
- Can conduct electricity like a metal.



Very Important Semiconductor

Silicon (has 4 valence electrons and typically found combined with oxygen in nature)

• Silicon is used in making microchips which need to withstand high heat in a computer but still able to transmit electrical current...more about this later!




Periodic Trends

- Elements become more metallic towards the <u>LEFT</u> and more nonmetallic towards the <u>RIGHT</u> on the periodic table
- The most reactive metals are on the FAR LEFT, and the more reactive nonmetals are ALMOST TO THE FAR RIGHT.
- The group (column) to the <u>FAR RIGHT</u> is <u>THE MOST NONREACTIVE</u>!